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Strycharske et al.

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(54) **METHOD AND APPARATUS FOR CONVECTIVE SILL INSULATION**

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E06B 3/263 (2006.01)
F24F 7/00 (2021.01)

(52) **U.S. Cl.**
CPC .. ***E06B 3/26347*** (2013.01); *E06B 2003/2633* (2013.01); *E06B 2003/26327* (2013.01); *E06B 2003/26352* (2013.01); *E06B 2003/26387* (2013.01); *F24F 2007/004* (2013.01); *Y10T 29/49826* (2015.01)

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See application file for complete search history.

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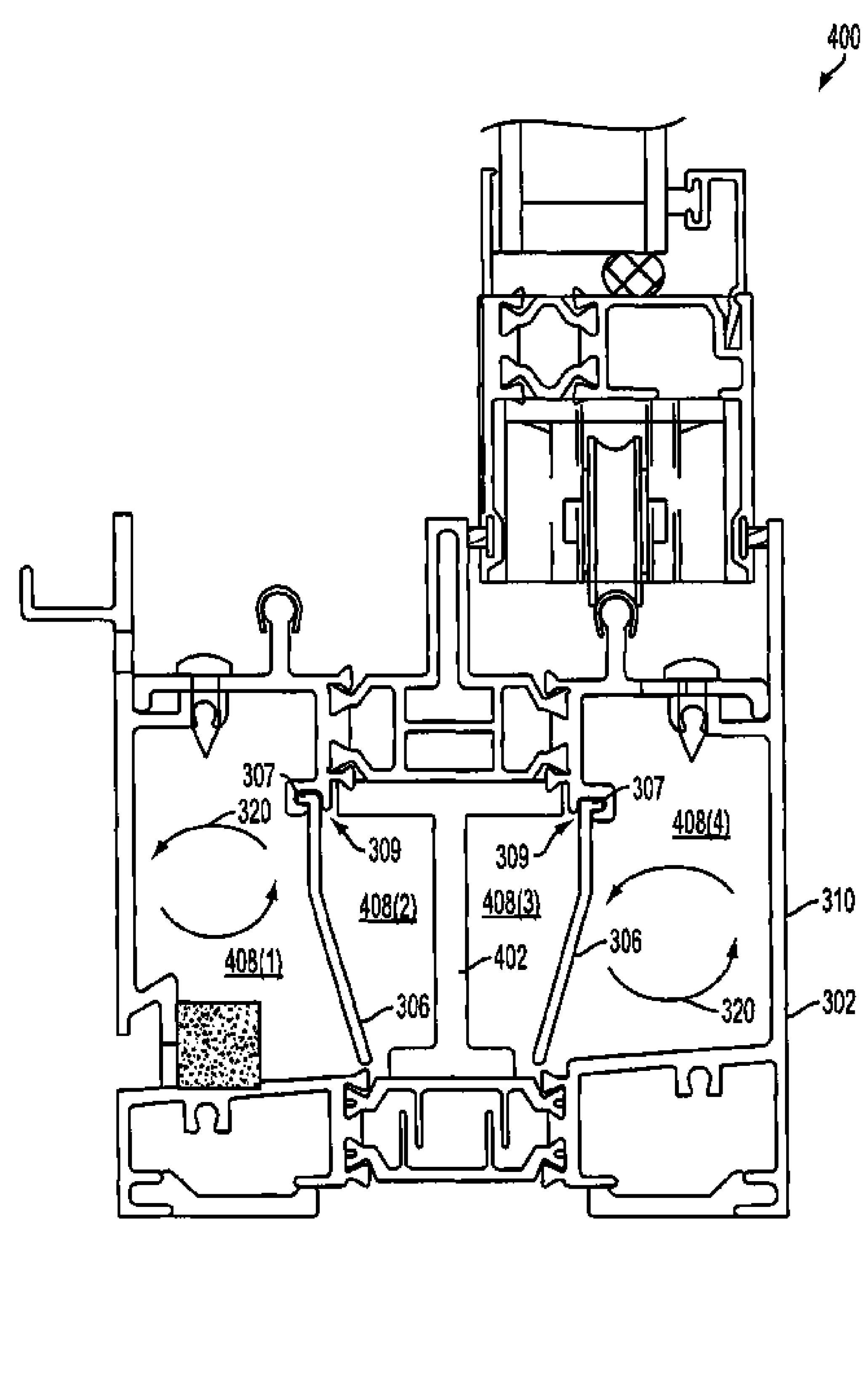
(57) **ABSTRACT**

The present application relates to an arrangement for reducing thermal energy loss through a sill assembly of the type used with a door or window. The sill assembly includes at least one sill member. The at least one sill member has a hollow region therein. The sill assembly further includes a baffle disposed within the at least one sill member. The baffle spans a length of the at least one sill member and divides the at least one sill member into a plurality of chambers thereby limiting interaction of warmer air and cooler air within the at least one sill member. The baffle reduces heat transfer through the hollow region via convection.

15 Claims, 8 Drawing Sheets



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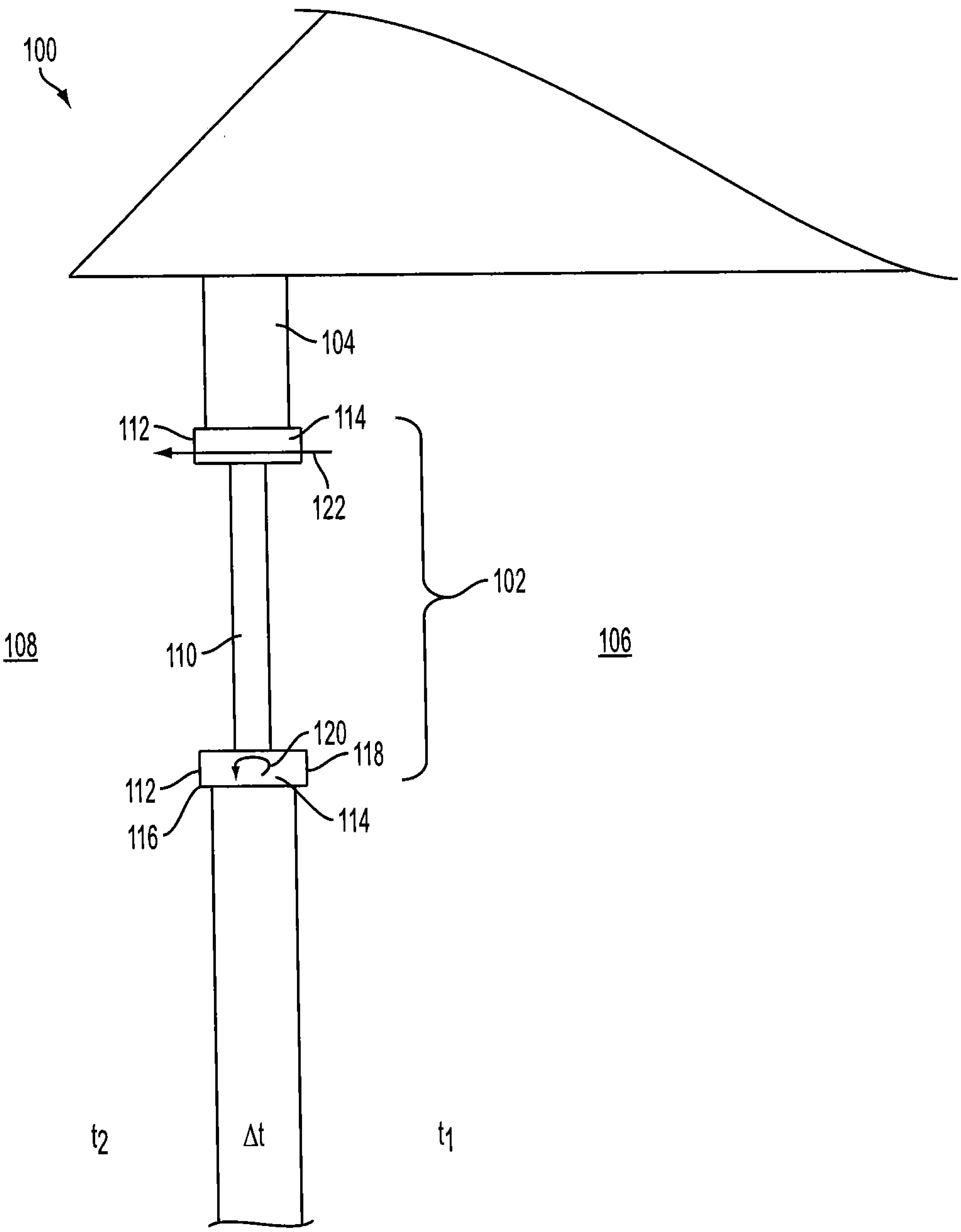

FIG. 1
PRIOR ART

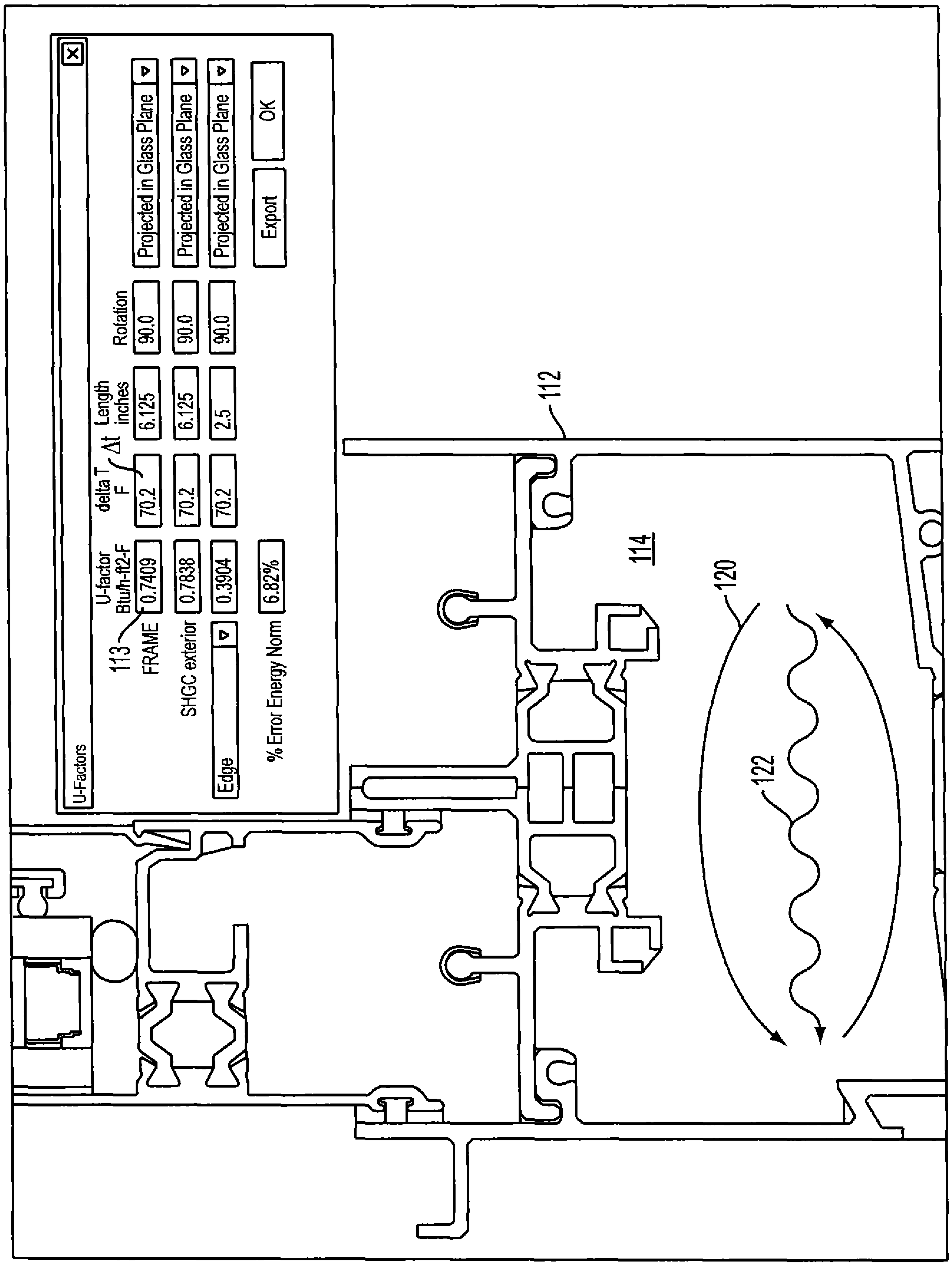

FIG. 2
PRIOR ART

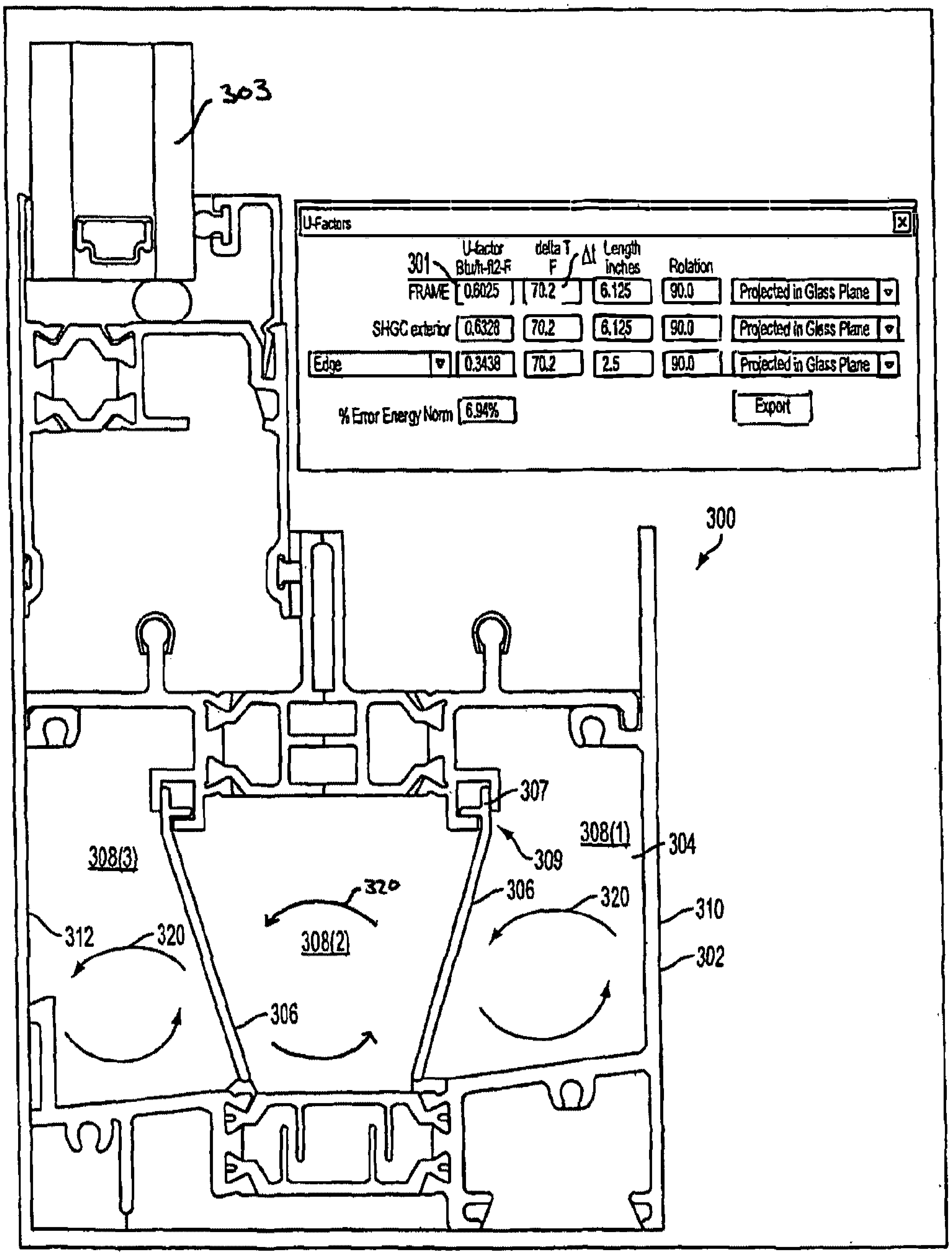
303
U-Factors
301
U-factor Btu/h-ft2-F
delta T F
Δt
Length inches
Rotation
FRAME
0.6025
70.2
6.125
90.0
Projected in Glass Plane
SHGC exterior
0.6328
70.2
6.125
90.0
Projected in Glass Plane
Edge
0.3438
70.2
2.5
90.0
Projected in Glass Plane
% Error Energy Norm
6.94%
Export
300
307
308(1)
304
309
308(3)
320
306
308(2)
312
310
302

FIG. 3

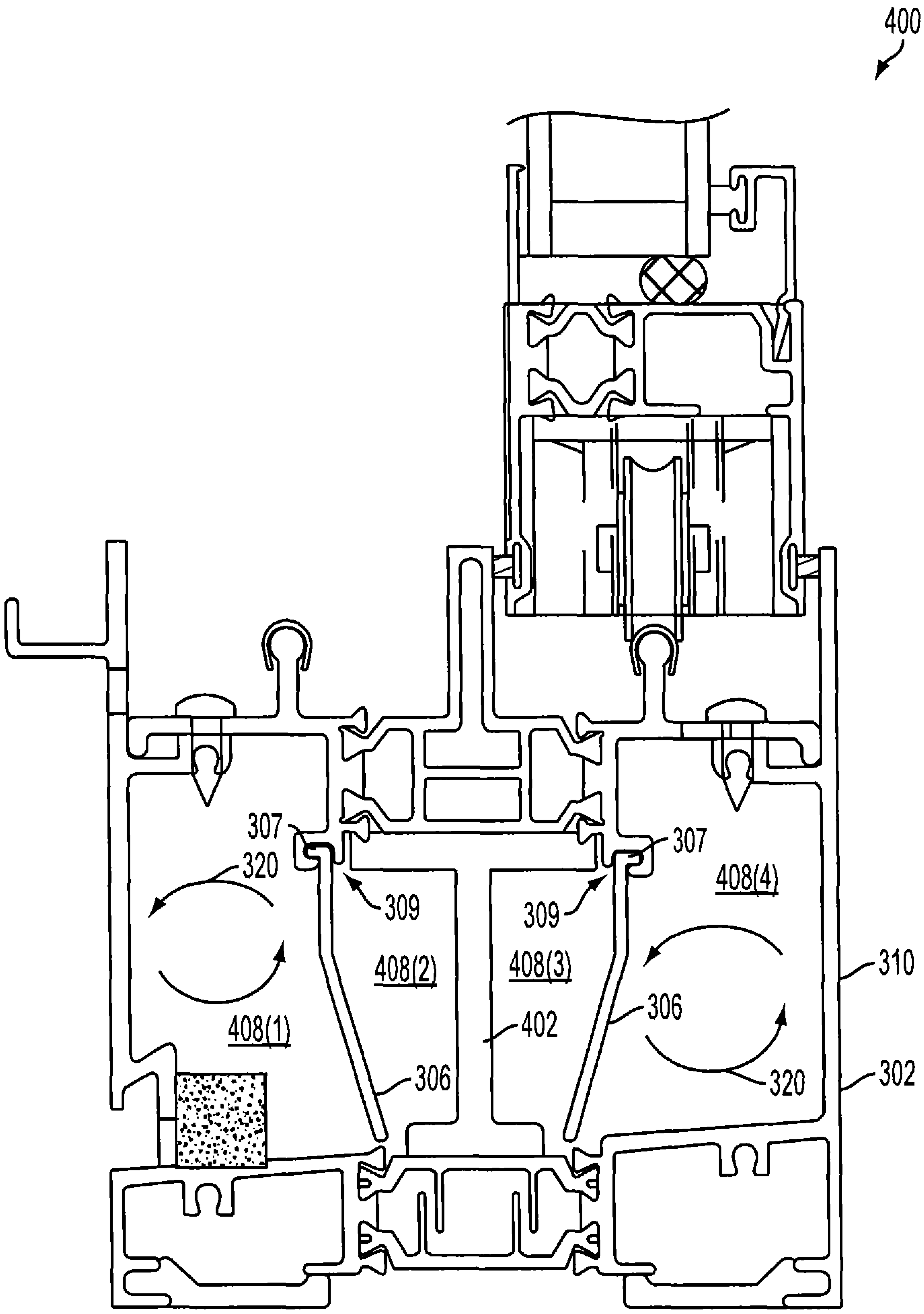
400
307
320
309
408(2)
408(1)
306
307
408(4)
309
408(3)
310
306
402
320
302

FIG. 4

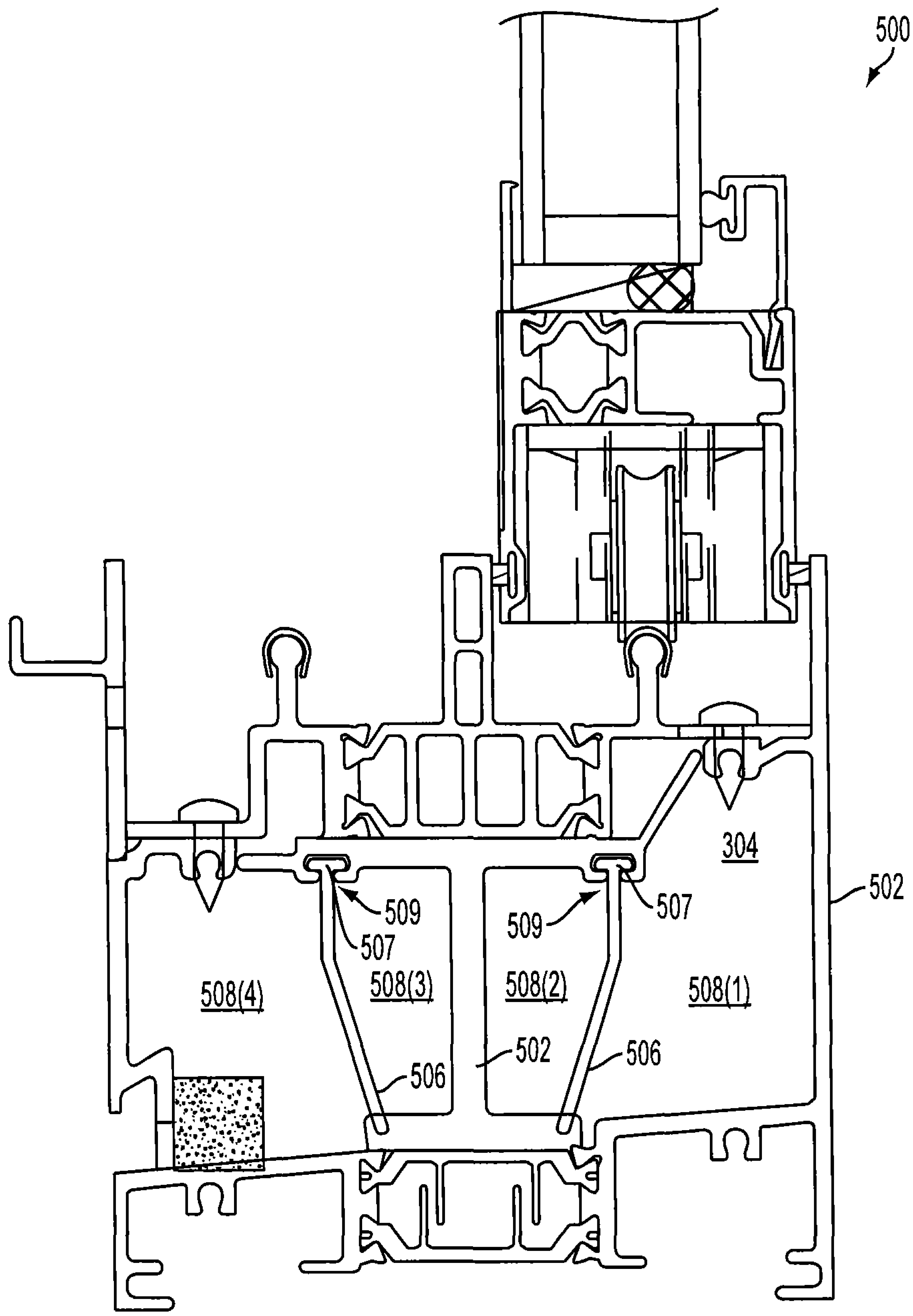

FIG. 5

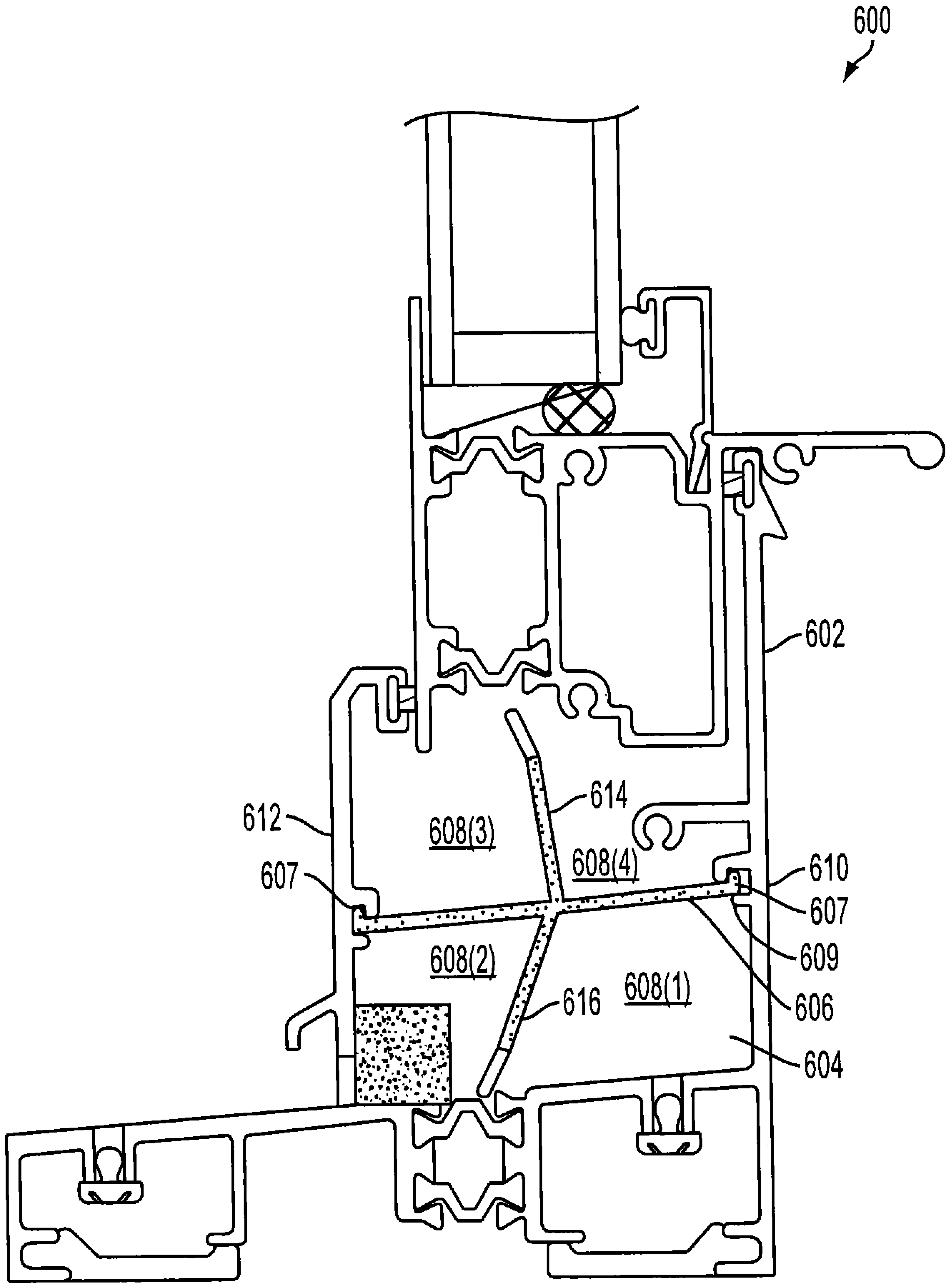

FIG. 6

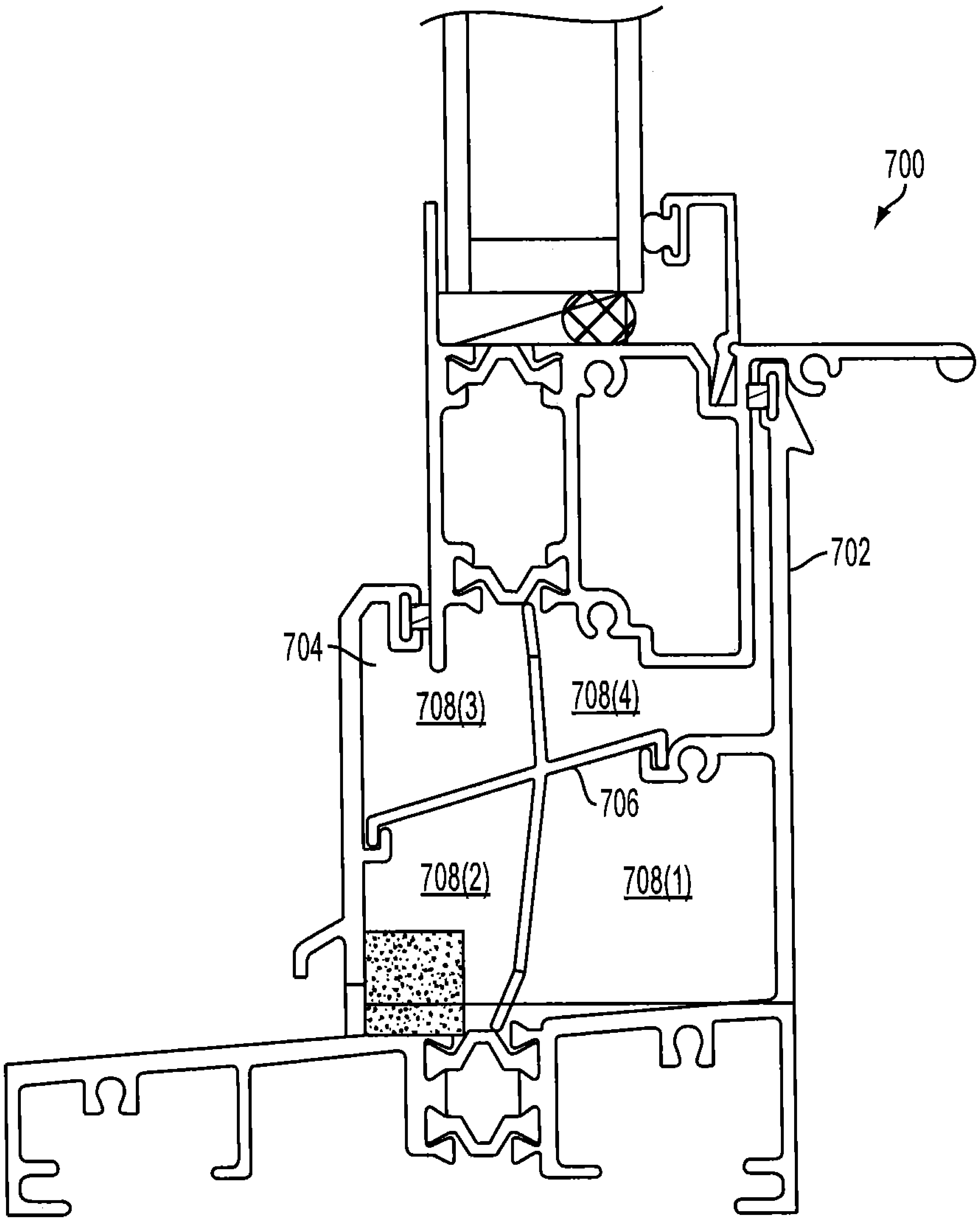

FIG. 7

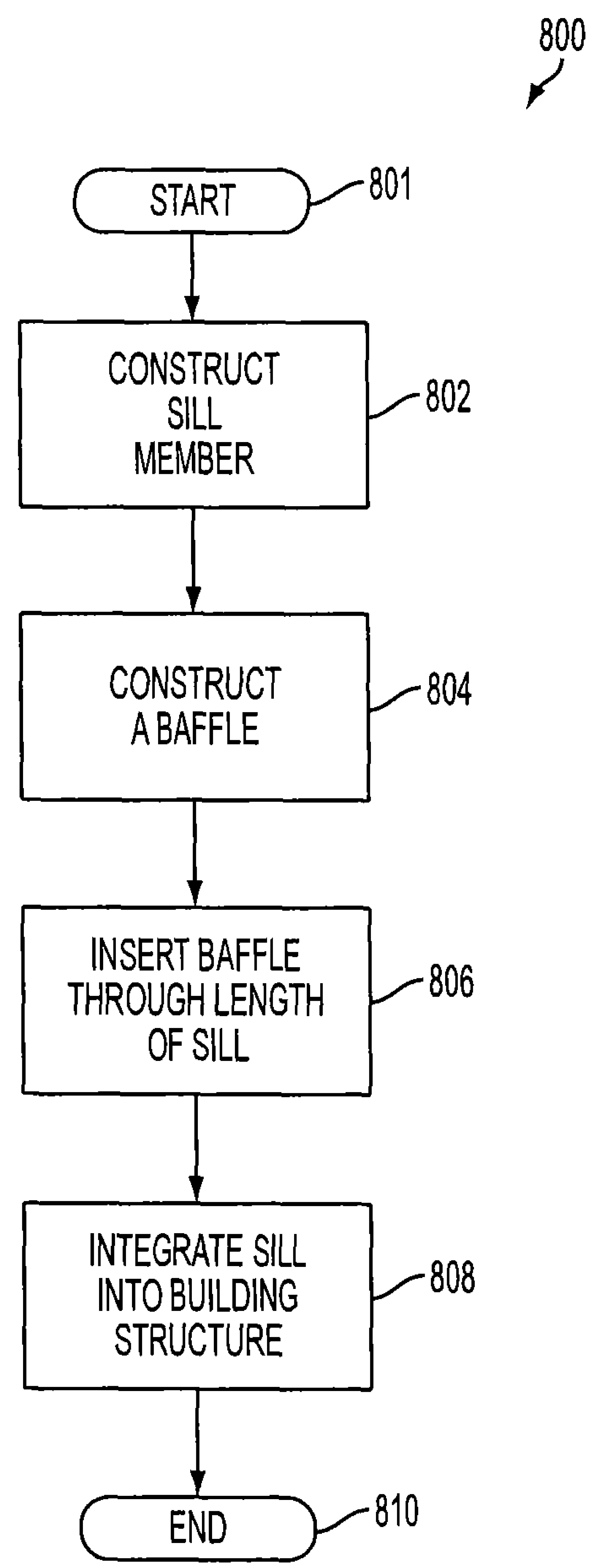
800
START
801
CONSTRUCT SILL MEMBER
802
CONSTRUCT A BAFFLE
804
INSERT BAFFLE THROUGH LENGTH OF SILL
806
INTEGRATE SILL INTO BUILDING STRUCTURE
808
END
810

FIG. 8

METHOD AND APPARATUS FOR CONVECTIVE SILL INSULATION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/396,126 filed on Feb. 14, 2012. U.S. patent application Ser. No. 13/396,126 claims priority to U.S. Provisional Patent Application No. 61/443,747, filed Feb. 17, 2011. U.S. patent application Ser. No. 13/396,126 and Provisional Patent Application No. 61/443,747 are incorporated herein by reference.

BACKGROUND

Field of the Invention

The present application relates to insulation methods and systems and more particularly, but not by way of limitation, to methods and systems for internal convective insulation of hollow sill components associated with, for example, doors and windows.

History of the Related Art

The trend of increasing prices for natural gas, electricity, and other heating fuels has made energy efficiency a high-profile issue. In buildings, thermal energy may be lost to the atmosphere through, for example, conduction, radiation, or convection. Conduction is a transfer of thermal energy between regions of matter due to a temperature gradient. Radiation is a transfer of thermal energy via electromagnetic waves. Convection takes place as a result of molecular movement, known as currents or convective looping, within fluids. A common mode of convection results from an inverse relationship between a fluid's density and temperature. Heating of a fluid results in a decrease in the fluid's density. Denser portions of the fluid fall while less dense portions of the fluid rise resulting in bulk fluid movement. Typically, such type of convection is referred to as "natural" or "free" convection. A common example of natural convection is a pot of boiling water in which hot (less dense) water at a bottom of the pot rises in plumes and cooler (more dense) water near a top of the pot sinks. The primary means of thermal energy loss across an un-insulated air-filled space is natural convection.

Thermal efficiency of building components is often expressed in terms of thermal resistance ("R-value") and thermal transmission ("U-factor"). R-value, a measurement of thermal conductivity, measures a product's resistance to thermal energy loss. In common usage, R-value is used to rate building materials that generally do not transfer significant amounts of thermal energy by convection or radiation such as, for example, insulation, walls, ceilings, and roofs. A product with a higher R-value is generally considered to be more energy efficient.

In building insulation, of particular concern are windows and doors. Windows, in particular, come into contact with the environment in ways that walls and solid insulation do not. As a result, windows are strongly affected by convection as well as radiation. For this reason, U-factor is commonly used as a measure of energy efficiency of windows. U-factor measures a total rate of heat transfer through a product (including heat transfer via convection and radiation). A product with a lower U-factor is generally considered to be more energy efficient. In recent years, federal, state, and municipal building codes often specify minimum R-values and U-factors for building components.

Door and window assemblies of most buildings typically include one or more sill members. In most buildings, the sill members may be constructed from, for example, extruded materials having a hollow cavity therein. In moderate conditions, air contained in the hollow cavity often provides sufficient insulation to prevent thermal energy loss through the sill members via, for example, conduction, convection, or radiation. However, in conditions where there is a large temperature difference between an interior temperature and an exterior temperature, the large temperature difference may induce thermal currents in air contained in the hollow cavity making thermal energy loss via convection through the sill members significant.

In window and door assemblies, solid insulation such as, for example, foam or fiberglass has been used to reduce thermal energy loss through conduction and convection. However, solid insulation is not well suited for use in exterior door and window sill applications for a variety of reasons. First, installation of solid insulation throughout a sill member may prove difficult and time consuming. Second, infiltration of moisture into solid insulation materials often fosters growth of, for example, bacteria, fungus, and other contaminants. Such contaminants can cause unpleasant odors, aggravate allergies, and cause illness.

SUMMARY

In one embodiment, the present application relates to a sill assembly. The sill assembly may include at least one sill member. The sill assembly may include a baffle disposed within a hollow region of the at least one sill member. The baffle divides the hollow region into a plurality of chambers thereby limiting interaction of warmer air and cooler air within the at least one sill member. The baffle reduces heat transfer via convection through the hollow region.

In another embodiment, the present application relates to a method for insulating a sill member. The method may include providing at least one sill member having a groove disposed in a hollow region thereof. The method may include providing a baffle sized to be disposed within the hollow region of the at least one sill member and inserting the baffle into the groove. The method may include arranging the baffle such that the hollow region of the at least one sill member is divided into a plurality of chambers.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and system of the present invention may be obtained by reference to the following Detailed Description when taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a schematic block diagram of a building having a prior-art sill assembly;

FIG. **2** is cross-sectional view of a prior-art sill assembly illustrating heat transfer via convection therethrough;

FIG. **3** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment;

FIG. **4** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment;

FIG. **5** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment;

FIG. **6** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment;

FIG. **7** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment; and

FIG. **8** is a flow diagram of a process for insulating a sill member according to an exemplary embodiment.

DETAILED DESCRIPTION

Various embodiments of the present invention will now be described more fully with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, the embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

FIG. **1** is a schematic block diagram of a building having a prior-art sill assembly. As used herein, the term "building" refers to any commercial or residential structure. A building **100** includes a window assembly **102** located in an exterior wall **104**. The exterior wall **104** separates an interior region **106** of the building **100** from an exterior region **108**. The window assembly **102** typically includes a pane **110** and at least one sill member **112**. The at least one sill member **112** may be constructed from, for example, extruded aluminum or other similar material. The at least one sill member **112** typically includes a hollow region **114** located therein. The interior region **106** of the building is maintained at a first temperature t_1. Likewise, the exterior region **108** is typically at a second temperature t_2. A temperature gradient Δt arises as a result of a difference between the first temperature t_1 and the second temperature t_2. The relationship between the first temperature t_1, the second temperature t_2, and the temperature gradient Δt is shown mathematically by Equation I:

$$\Delta t = t_2 - t_1 \qquad \text{Equation I:}$$

Still referring to FIG. **1**, by way of further illustration, if the first temperature t_1 is assumed to be, for example, 72° F. and the second temperature t_2 is assumed to be, for example, −5° F., then the temperature gradient Δt is −77° F. In various embodiments, if the temperature gradient Δt is large, such as, for example, +/−70° F. or greater, an air temperature inside the hollow region **114** changes. By way of example, in the case illustrated above, air that is close in proximity to an exterior surface **116** of the at least one sill member **112** is gradually cooled and air that is close in proximity to an interior surface **118** of the at least one sill member **112** is gradually heated. The change in temperature of air inside the hollow region **114** causes an air density to change in accordance with the ideal gas law illustrated by Equation II

$$\rho = \frac{p}{R \cdot T} \qquad \text{Equation II}$$

where ρ is air density, p is absolute air pressure, R is the specific gas constant, and T is absolute temperature. By way of example, the specific gas constant for dry air is generally known to be 287.058 J/(kgK). In accordance with the ideal gas law, the density of warmer air will decrease and the density of cooler air will increase.

Still referring to FIG. **1**, as air temperature in the hollow region **114** changes, warmer, less dense air begins to rise while cooler, denser air begins to settle at a bottom region of the hollow region **114**. This change in air density causes a circulation of air (illustrated in FIG. **1** with arrow **120**) within the hollow region **114** resulting in heat transfer through the hollow region **114** via, for example, convection (illustrated in FIG. **1** with arrow **122**).

FIG. **2** is a cross-sectional view of a prior-art sill assembly illustrating heat transfer via convection therethrough. A sill member **112**, includes a hollow region **114** located therein. The hollow region **114** is typically filled with a fluid such as, for example, air. As discussed above with respect to FIG. **1**, in situations where the temperature gradient Δt (shown in FIG. **1**) is large, the air circulation **120** is induced enabling the heat transfer **122** through the hollow region **114** via, for example, convection. By way of example, FIG. **2** illustrates an exemplary temperature gradient Δt of 70.2° F. The arrangement shown in FIG. **2** yields an exemplary U-factor **113** of 0.7409 BTU/hr●ft^2●° F.

FIG. **3** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment. A window assembly **300** includes at least one sill member **302**. In various embodiments, the at least one sill member **302** may be constructed from, for example, extruded aluminum or other similar material. The at least one sill member **302** includes a hollow region **304** located therein. At least one baffle **306** is disposed within the hollow region **304**. The at least one baffle **306** extends from a top region of the hollow region **304** to a bottom region of the hollow region **304** and divides the hollow region **304** into a plurality of chambers **308(1)-308(3)**. In various embodiments, the at least one baffle **306** may be constructed from materials such as, for example, rubber, polyvinylchloride (PVC), silicone, generally rigid plastic, or other thermally non-conductive material. In various embodiments, the at least one baffle **306** includes a wedge portion **307**. The wedge portion **307** engages a groove **309** formed within the hollow region **304**. In a typical embodiment, the groove **309** spans a length of the at least one sill member **302**. In various embodiments, the at least one baffle **306** may be integrally formed within the at least one sill member **302**. By way of example, two baffles **306** are shown in FIG. **3** dividing the hollow region **304** into three chambers **308 (1)-(3)**; however, one of ordinary skill in the art will recognize that in various alternative embodiments any number of baffles **306** may be utilized.

Still referring to FIG. **3**, a temperature gradient Δt (shown in FIG. **1**) arises as a result of a difference between a first temperature t_1 (shown in FIG. **1**) and a second temperature t_2 (shown in FIG. **1**). In conditions where there is a large difference between an exterior and an interior temperature, a temperature of air inside the hollow region **304** changes. For example, air that is in close proximity to an interior surface **310** of the at least one sill member **302** may be at a higher temperature while air that is in close proximity to an exterior surface **312** of the at least one sill member **302** may be at a lower temperature. In various embodiments, the exterior surface **312** of the at least one sill member **302** may be at a warmer temperature than the interior surface **310**. In such embodiments, air that is close in proximity to the interior surface **310** may be at a lower temperature while air that is close in proximity to the exterior surface **312** may be at a higher temperature. Such heating and cooling of air within the hollow region **304** causes an air density to change in accordance with the ideal gas law resulting in circulation of the air within the hollow region **304** (shown by arrow **320**). In a typical embodiment, the at least one baffle **306** extends from a top region of the hollow region **304** to a bottom region of the hollow region **304** and divides the hollow region **304** into the plurality of chambers **308(1)-308(3)**. Thus, the at least one baffle **306** limits interaction of warmer air and cooler air thereby preventing significant heat transfer via convection across the hollow region **304**. This is illustrated in FIG. **3** with arrows **320** showing convective looping within each of the plurality of chambers **308(1)-308(3)**. In this manner, the at least one baffle **306** provides insulation against thermal energy loss due to convection. By way of example, FIG. **3** illustrates an exemplary temperature gradient Δt of 70.2° F. The arrangement shown in FIG. **3** yields an exemplary U-factor **301** of 0.6025 BTU/hr●ft^2●° F.

FIG. **4** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment. A window assembly **400** is similar in construction to the window assembly **300**; however, the window assembly **400** includes a support member **402** disposed in the approximate center of the hollow region **304**. In a typical embodiment, the support member **402** may be constructed of, for example, rubber, polyvinylchloride (PVC), silicone, generally rigid plastic, or other thermally non-conductive material. In a typical embodiment, the support member **402** spans a length of the at least one sill member **302**; however, in various alternative embodiments, the support member **402** may not extend an entire length of the at least one sill member **302**. In various embodiments, the support member **402** is integrally formed with the at least one sill member **302**. In a typical embodiment, the support member **402** further divides the hollow region **304** into a plurality of chambers **408(1)-408(4)**.

FIG. **5** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment. A window assembly **500** is similar in construction to the window assembly **400**. The window assembly **500** includes a support member **502** and at least one baffle **506**. The at least one baffle **506** includes a wedge portion **507**. The wedge portion engages a groove **509** formed in the support member **502**. Thus, the support member **502** and the at least one baffle **506** may be inserted and removed from the hollow region **304** as an integral unit. In a typical embodiment, the support member **502** and the at least one baffle **506** are constructed of, for example, rubber, polyvinylchloride (PVC), silicone, or other thermally non-conductive material. In a typical embodiment, the support member **502** and the at least one baffle **506** extend an entire length of the at least one sill member **302**; however, in alternative embodiments, the support member **502** does not extend an entire length of the at least one sill member **302**. The support member **502** further divides the hollow region **304** into a plurality of chambers **508(1)-508(4)**.

FIG. **6** is a cross-sectional diagram of a sill assembly including a baffle according to an exemplary embodiment. A window assembly **600** includes at least one sill member **602**. In various embodiments, the at least one sill member **602** may be constructed from, for example, extruded aluminum, fiberglass, or other thermally non-conductive material. The at least one sill member **602** has a hollow region **604** located therein. At least one baffle **606** is disposed within the hollow region **604**. The at least one baffle **606** extends from an interior surface **610** of the hollow region **604** to an exterior surface **612** of the hollow region **604**. The at least one baffle **606** includes a first finger **614** projecting from a top of the at least one baffle **606** and a second finger **616** projecting from a bottom of the at least one baffle **606**. The first finger **614** extends from the at least one baffle **606** to a top region of the hollow region **604**. The second finger **616** extends from the at least one baffle **606** to a bottom region of the hollow region **604**. In a typical embodiment, combination of the at least one baffle **606**, the first finger **614**, and the second finger **616** divides the hollow region **604** into a plurality of chambers **608(1)-608(4)**.

Still referring to FIG. **6**, in various embodiments, the at least one baffle **606** may be constructed from materials such as, for example, rubber, polyvinylchloride (PVC), or other thermally non-conductive material. In various embodiments, the at least one baffle **606** includes wedge portions **607**. The wedge portions **607** engage grooves **609** formed within the hollow region **604**. In a typical embodiment, the grooves **609** span a length of the at least one sill member **602**. In other embodiments, the at least one baffle **606**, the first finger **614**, and the second finger **616** may be integrally formed within the at least one sill member **602**. By way of example, the hollow region **604** is shown in FIG. **6** as being divided into four chambers **608**; however, one skilled in the art will recognize that any number or combination of the at least one baffle **606**, the first finger **614**, and the second finger **616** could be used to divide the hollow region **604** into any number of chambers **608**.

Still referring to FIG. **6**, during operation, the at least one baffle **606** disrupts formation of convective currents or convective looping within the hollow region **604**. Without convective looping, heat transfer across the at least one sill member **602** via convection is reduced. Thus, placement of the at least one baffle **606** provides insulation against loss of thermal energy due to convection.

FIG. **7** is a cross-sectional view of a sill assembly including a baffle according to an exemplary embodiment. A window assembly **700** includes at least one sill member **702**. In various embodiments, the at least one sill member **702** may be constructed from, for example, extruded aluminum, fiberglass, or other thermally non-conductive material. The at least one sill member **702** has a hollow region **704** located therein. At least one baffle **706** is disposed within the hollow region **704**. The at least one baffle **706** is similar in construction to the at least one baffle **606** (shown in FIG. **6**). In a typical embodiment, the baffle **706** divides the hollow region **704** into a plurality of unequally-sized chambers **708(1)-708(4)**.

FIG. **8** is a flow diagram of a process for insulating a sill member according to an exemplary embodiment. A process **800** begins at step **801**. At step **802**, at least one sill member having a hollow region is constructed. At step **804**, at least one baffle is constructed. At step **806**, the at least one baffle is inserted through a length of the hollow region of the at least one sill member. At step **808**, the at least one sill member is integrated into a building. The process **800** ends at step **810**.

Although various embodiments of the method and system of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth herein. For example, although the present invention has primarily been described herein as insulating against loss of thermal energy from an interior region of a building to an exterior region; one skilled in the art will recognize that the present invention could also be used to prevent the infiltration of thermal energy from an exterior region into an interior region of a building. This would arise in cases where the interior region of the building is cooler than the exterior region. Next, although the present invention has been primarily described herein as insulating sill members associated with windows, one skilled in the art will recognize that the principles of the present invention could be used to insulate a variety of building structures such as, for example, walls, roofs, doors, vents, skylights, curtain walls, and any other building components having a fluid-filled cavity. The embodiments described herein should be taken as illustrative only.

What is claimed is:

1. A sill assembly comprising:
at least one sill member constructed of a first material, the sill member defining a hollow region;
a baffle slidably coupled to an upper aspect of the at least one sill member and disconnected from a lower aspect of the at least one sill member, the first baffle being constructed of a second material, the first baffle being angled toward a center of the at least one sill member;
a first finger projecting from a top surface of the first baffle and a second finger projecting from a bottom surface of the first baffle;
a second baffle slidably coupled to the upper aspect of the at least one sill member and disconnected from a lower aspect of the at least one sill member, independent of the first baffle such that the second baffle is not in direct contact with the first baffle, the second baffle being constructed of the second material, the second baffle being angled toward the center of the at least one sill member;
a support member disposed within the at least one sill member between the first baffle and the second baffle, the support member extends from a top edge of the at least one sill member to a bottom edge of the at least one sill member, the support member being constructed of the second material, the support member comprising a first horizontal member disposed against the top edge of the at least one sill member, a second horizontal member disposed against a bottom edge of the at least one sill member, and a vertical web connecting the first horizontal member and the second horizontal member, the first horizontal member having a length greater than the second horizontal member;
a plurality of chambers formed in the hollow region, the plurality of chambers being defined by the first baffle, the second baffle, and the sill member limiting interaction of warmer air and cooler air within the at least one sill member; and
wherein the first baffle and the second baffle reduce heat transfer via convection through the hollow region.

2. The sill assembly of claim 1, wherein the plurality of chambers comprises two chambers.

3. The sill assembly of claim 1, wherein the plurality of chambers comprises three or more chambers.

4. The sill assembly of claim 1, wherein the first baffle and the second baffle are constructed from at least one of rubber, polyvinylchloride, silicone, or generally rigid plastic.

5. The sill assembly of claim 1, wherein the at least one sill member is a component of a window.

6. The sill assembly of claim 1, wherein the at least one sill member is a component of a door.

7. The sill assembly of claim 1, wherein the first baffle and the second baffle span a length of the at least one sill member.

8. The sill assembly of claim 1, wherein the at least one sill member comprises a first groove and a second groove.

9. The sill assembly of claim 8, wherein the first baffle is received in the first groove and the second baffle are received in the second groove.

10. A method for insulating a sill member, the method comprising:
providing at least one sill member having a first groove and a second groove disposed within an upper aspect of a hollow region thereof, the at least one sill member constructed of a first material, the first groove and the second groove being offset from a centerline of the at least one sill member on respective sides of the at least one sill member;
providing a first baffle and a second baffle, the first baffle and the second baffle being sized to be disposed within the hollow region, the first baffle and the second baffle being constructed of a second material, the first baffle comprising a first finger projecting from a top surface of the first baffle and a second finger projecting from a bottom surface of the first baffle;
inserting the first baffle into the first groove, such that the first baffle remains disconnected from a lower aspect of the at least one sill member and the first baffle is angled toward the centerline of the at least one sill member;
inserting the second baffle into the second groove independent of the first baffle such that the second baffle remains disconnected from a lower aspect of the at least one sill member and the first baffle is not in direct contact with the first baffle, and the second baffle is angled toward the centerline of the at least one sill member;
inserting a support member within the at least one sill member between the first baffle and the second baffle such that the support member extends from a top edge of the at least one sill member to a bottom edge of the at least one sill member, the support member being constructed of the second material, the support member comprising a first horizontal member disposed against the top edge of the at least one sill member, a second horizontal member disposed against a bottom edge of the at least one sill member, and a vertical web connecting the first horizontal member and the second horizontal member, the first horizontal member having a length greater than the second horizontal member; and
arranging the first baffle and the second baffle such that the hollow region of the at least one sill member is divided into a plurality of chambers.

11. The method of claim 10, wherein the first baffle and the second baffle are constructed from at least one of rubber, polyvinylchloride, silicone, or generally rigid plastic.

12. The method of claim 10, wherein the plurality of chambers comprises three or more chambers.

13. The method of claim 10, wherein the at least one sill member is a component of a window.

14. The method of claim 10, wherein the at least one sill member is a component of a door.

15. The method of claim 10, wherein the first baffle and the second baffle span a length of the at least one sill member.

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